

A SURVEY OF THREE INDUSTRIALIZED AREAS IN EASTERN  
TENNESSEE FOR SYMPTOMS OF AIR POLLUTION  
INJURY TO VEGETATION

By

Bruce Kauffman, William Sites, and Betty White<sup>1/</sup>

ABSTRACT

In June and September of 1975, three areas of eastern Tennessee were surveyed for evidence of air pollution injury to vegetation. The surveys centered around four potential sources and included parts of six counties. Several species of vegetation were examined around each source for a 5-mile radius. In only one instance was there decline and mortality similar to that associated with phytotoxic emissions. However, foliar analysis of the only affected species failed to establish an air pollutant as the causal agent.

INTRODUCTION

Air pollution, now recognized as a serious disease-causing agent particularly in urban and industrial areas, can cause both dramatic and subtle effects. Many tree species are quite susceptible and die quickly while others gradually decline in vigor and rate of growth. Species of less apparent value may even disappear unnoticed.

Several surveys have been conducted in the Southeast to pinpoint which specific areas are subject to atmospheric pollutants. No actual air quality data have been collected. The surveys are based solely on symptoms expressed by vegetation. In one instance, however, an analysis

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<sup>1/</sup> Forest Insect & Disease Specialist, Tennessee Department of Conservation, Division of Forestry, Nashville, TN 37203

Plant Pathologist, Forest Pest Management, Southeastern Area, S&PF, Asheville, NC 28803

Former Biological Technician, Forest Pest Management, Southeastern Area, S&PF, Asheville, NC 28803

of vegetation for chemical content was carried out for further verification.

## METHODS

Three areas were selected in eastern Tennessee because of the possible high level of emissions typical of industries in each. They included the vicinity of the Kingston Steam Plant, Kingston, Tennessee, for possible injury from  $\text{SO}_2$  and the area around the Tennessee Farmers Co-op near Rockford for symptoms of ammonia and fluoride resulting from the manufacture of fertilizer. The third area centered around Charleston for hydrogen sulfide emissions from the Hiwassee Bowaters facility and for chloride injury adjacent to the Olin Corporation's Charleston Works.

The surveys consisted of roughly circular plots laid out on topographic maps with the point source located at the center. Highways and roads within a 5-mile radius dictated the coverage within the plots. In all cases, an attempt was made to conduct the survey in an ever widening circle, using the source as the center. This was to insure that survey lines were set as much as possible at right angles to radii from the center. Each of the three areas encompassed approximately 50,140 acres or a total of 150,420 acres. Within the survey area, trees and other vegetation were examined closely for symptoms of injury caused by any of the possible phytotoxic chemicals (Table 1).

Seven points were established near the Olin facility. Five of the points were established in the direction of prevailing winds. Two were established in the opposite direction (Table 2).

Table 2. Direction and distance of each of seven points from Olin facility near Charleston.

| Point No | Direction from Olin | Distance from Olin (ft.) |
|----------|---------------------|--------------------------|
| 1        | Downwind            | 1,000                    |
| 2        | Downwind            | 2,000                    |
| 3        | Downwind            | 3,000                    |
| 4        | Downwind            | 4,000                    |
| 5        | Downwind            | 7,000                    |
| 6        | Upwind              | 1,000                    |
| 7        | Upwind              | 5,000                    |

At each sample point, five symptomatic eastern redcedar (*Juniperus virginiana*) trees were sampled. From each tree, the current year's growth was removed from an average of six branches that faced the source. These were kept under refrigeration until analyzed for chloride ( $\text{Cl}^-$ ) content by the silver electrode method (Donald D. Davis, Air Pollution Specialist, Pennsylvania State University, personal communication).

Table 1. Tabulation of surveys showing acreages and indicator species examined.

| Survey No. | Area                         | Counties          | Date of Survey                                   | Potential Emission and Source                                                              | Acreage | Species Examined                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------|------------------------------|-------------------|--------------------------------------------------|--------------------------------------------------------------------------------------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1          | Kingston                     | Morgan<br>Roane   | June 24, 1975                                    | SO <sub>2</sub> - Kingston<br>Steam Plant                                                  | 50,140  | Blackberry ( <i>Rubus</i> sp.)<br>Giant Ragweed ( <i>Ambrosia trifida</i> )<br>Greenbrier ( <i>Smilax</i> sp.)<br>Jewel Weed ( <i>Impatiens biflora</i> )<br>Lambs-Quarters ( <i>Chenopodium album</i> )<br>Lespedeza ( <i>Lespedeza</i> sp.)<br>Lesser Ragweed ( <i>Ambrosia artemisiifolia</i> )<br>Pennsylvania Smartweed ( <i>Polygonum pennsylvanicum</i> )<br>Redbud ( <i>Cercis canadensis</i> )<br>Redclover ( <i>Trifolium pratense</i> )<br>Sassafras ( <i>Sassafras albidum</i> )<br>Virginia Pine ( <i>Pinus virginiana</i> )<br>White Pine ( <i>Pinus strobus</i> ) |
| 2          | 2 mi. N.<br>of<br>Rockford   | Knox<br>Blount    | June 25, 1975                                    | FI & NH <sub>3</sub> -<br>Fertilizer<br>Plant                                              | 50,140  | American Elm ( <i>Ulmus americana</i> )<br>Ash ( <i>Fraxinus</i> sp.)<br>Blackberry ( <i>Rubus</i> sp.)<br>Boxelder ( <i>Acer negundo</i> )<br>Greenbrier ( <i>Smilax</i> sp.)<br>Poison Ivy ( <i>Rhus radicans</i> )<br>Red Maple ( <i>Acer rubrum</i> )<br>Redbud ( <i>Cercis canadensis</i> )<br>Sassafras ( <i>Sassafras albidum</i> )<br>Smooth Sumac ( <i>Rhus glabra</i> )<br>White Pine ( <i>Pinus strobus</i> )<br>Wild Grape ( <i>Vitis</i> sp.)<br>Virginia Pine ( <i>Pinus virginiana</i> )                                                                          |
| 3          | Calhoun<br>and<br>Charleston | McMinn<br>Bradley | June 26, 1975<br><br>Resurveyed<br>Sept. 9, 1975 | H <sub>2</sub> S - Pulp Mill<br>Cl - Manufacture<br>of compounds<br>containing<br>chlorine | 50,140  | Apple ( <i>Malus</i> sp.)<br>Apple, Crab ( <i>Malus baccata</i> )<br>Blackberry ( <i>Rubus</i> sp.)<br>Eastern Redcedar ( <i>Juniperus virginiana</i> )<br>Greenbrier ( <i>Smilax</i> sp.)<br>Hickory ( <i>Carya</i> sp.)<br>Lambs-Quarters ( <i>Chenopodium album</i> )<br>Loblolly Pine ( <i>Pinus taeda</i> )<br>Mock Orange ( <i>Philadelphus</i> sp.)                                                                                                                                                                                                                       |

Table No. 1 - Survey No. 3 - Species Examined Continued.

Oak (*Quercus* sp.)  
Osage-Orange (*Maclura pomifera*)  
Privet (*Ligustrum* sp.)  
Ragweed (*Amaranthus retroflexus*)  
Sassafras (*Sassafras albidum*)  
Smooth Sumac (*Rhus glabra*)  
Sweetgum (*Liquidambar styraciflua*)  
Virginia Creeper (*Porthenocissus*  
                    *quinquefolia*)  
Virginia Pine (*Pinus virginiana*)  
White Pine (*Pinus strobus*)  
Yellow Poplar (*Liriodendron*  
                    *tulipifera*)

## RESULTS

In each survey area, a variety of species was observed. No symptoms were observed in the vicinities of Kingston and Rockford. However, in one section of the area surveyed near Charleston, decline and mortality of eastern redcedar were observed over an area of one-third square mile (Fig. 1). These symptoms were most evident east, west, and south of the Olin plant and west of the Hiwassee Bowaters facility.

Analysis of redcedar foliage revealed that the chloride (Cl-) content was low and probably not a factor in the decline of the trees sampled.

## DISCUSSION

Since no consistent injury patterns were observed in the Kingston or Rockford areas, it is unlikely that emissions prior to the survey were released in toxic dosages. This does not eliminate the possibility that conditions will remain so in the future.

In the area near Charleston, the cause for the decline and mortality of eastern redcedar has not been determined. Insects and diseases other than air pollution were eliminated early in the investigation for lack of evidence. For this reason, toxicity from chlorides was considered a possibility due to the proximity to Olin Corporation and the fact that steel in the gate hinges and galvanized window screening in the area was heavily corroded.

However, no other plant species other than eastern redcedar bore symptoms and the results of foliage analysis do not support this theory. Concentrations of chloride in foliage collected at the five downwind sample points ranged from 0.27 to 0.38 percent. The range for the two upwind points was higher; being 0.41 and 0.63 percent. Thus, the intended controls contained a higher concentration of chloride than the trees in the test plots.

If the Olin facility was the source of the chloride, periodic wind shifts and conditions favoring greater uptake and retention at the site of the controls may have resulted in greater chloride content.

The surveys conducted in eastern Tennessee were intended to locate areas subjected to phytotoxic emissions as evidenced by symptomatic vegetation. Consequently, areas surveyed were chosen for their proximity to preselected industries. However, this should not be interpreted as an indication that these industries were known to be releasing phytotoxic chemicals. No attempt was made to monitor air quality in any of the survey areas.



Figure 1. Top decline and mortality of eastern redcedar (*Juniperus virginiana*) near Charleston, Tennessee. Closeup of single tree (bottom).